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The welfare of pigs in rustic and technified production systems using the Welfare Quality protocols of pigs in Mexico: Validity of indicators of animal welfare as part of the sustainability criteria of pig production systems

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Abstract

The Welfare Quality® (WQ) protocols have been developed as a tool for the assessment of farm animal welfare based on scientific evidence. Animal welfare (AW) is part of the sustainability criteria of livestock production. A study was carried out in four states of Central Mexico in seven rustic (rPS) and six technified (tPS) production systems using the WQ protocol with the objective of providing an initial approximation of the welfare of animals and to discuss the validity of indicators of AW. The results showed that the animals housed in rustic units presented better results in the *Good Health* category and with respect to the criterion *expression of social behaviour*, while the frequency of criteria concerning *Positive emotional states* was higher in animals in the technified units. In the changing context in which the farms operate, including changing agricultural policies, new environmental and food safety regulations, variability of climatic conditions, and volatility in prices of inputs and outputs, it is not only the attributes referring to productivity and efficiency that become relevant. It is concluded that the criteria related to the WQ principles of health and behaviour are sensitive to changes in the housing and management of pigs. The high occurrences of health and behaviour problems recorded in technified systems are an indicator of poor welfare.

Keywords: animal welfare; pig behaviour and health; pig production; sustainability; Welfare Quality.

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Introduction

The concept of animal welfare (AW) based on science has been adopted by the World Organization for Animal Health (2007) as part of a global strategy to adopt AW standards in member countries.[1,2] Particularly in Latin America, a regional strategy on AW is being integrated as part of a One Welfare approach [3] and applied from a sustainability point of view. In this sense, AW is seen as part of the sustainable livestock production criteria. In order to assess sustainability criteria, it is important to have reliable animal welfare indicators. The Welfare Quality® (WQ) protocols were developed as an AW assessment tool from a scientific point of view. These protocols were developed for three species: poultry, cattle, and pigs, and take into account four parameters: feeding, housing, health, and behaviour.[4]

Mexico is an important meat producer. One of the main production systems that contribute meat and derivatives is the pork sector, which has adapted to the Mexican economy because of its great versatility. According to national statistical data, it is estimated that the consumption of pork exceeds 1.9 million tons per year.[5] Pig production systems in Mexico are oriented by two models: the technified, in which a large number of animals are managed in small spaces and which produces approximately 50% of the total meat output, and rustic production systems, which are characterized by keeping animals in small extensions of land in or near the housing yard and which produces approximately 20-30% of the pork in the country.[6]

During the last fifty years, the form of production within pig farming has changed. In general, the pork industry has been managed with the goal of producing pork at the lowest possible cost and with the highest profit; through years of unilateral commitment to genetics and nutrition, social and environmental sustainability as well as animal welfare have been ignored.[7] Currently, both environmental and animal welfare issues must be considered in order to develop more efficient pig production systems, including less technified models, that can offer added value for these criteria.

The present study takes a closer look at the welfare of pigs in these rustic and technified production systems using the WQ protocols for pigs in Mexico. The data obtained will provide a first approximation of the welfare of animals by applying the Welfare Quality protocols in rustic and technified production systems, and will help to discuss the validity of indicators of AW as part of the sustainability criteria of pig production systems.

Materials and methods

Location and subjects

Geographical location of the area studied

The study region is located within the temperate zone characteristic of Mexican sierras, with rains in summer, and an average annual temperature range of 18° to 24°C.[8] It is the most economically important region where the two systems of pig production can be found.

Seven rustic production units (UPr) were evaluated along with six technified production units (UPt), all representative of the pig production system located in the states of Hidalgo (2 UPr, 1 UPt), Tlaxcala (4 UPr, 2 UPt), Morelos (3 UPt), and

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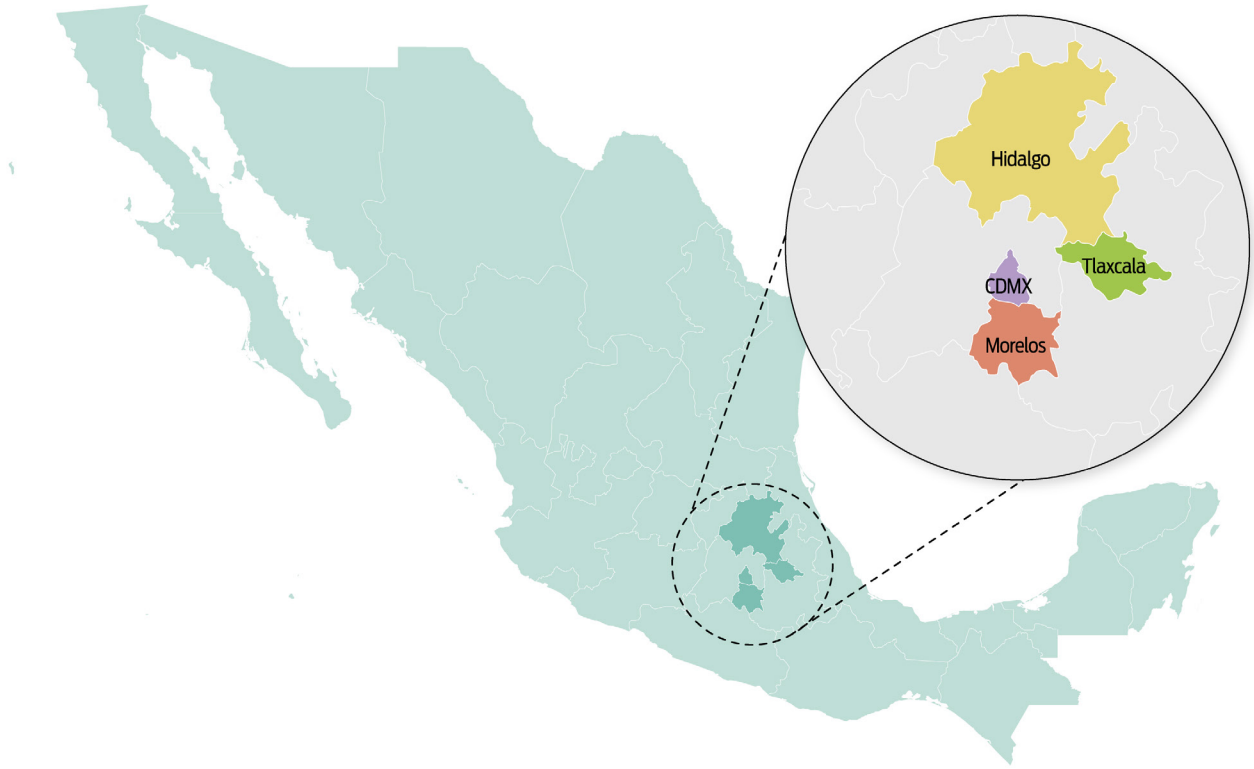

Figure 1. States where rustic and technified production units were evaluated in the Central Region of Mexico (Elaborated from Google data).

Mexico City (1 UPr). All of these states are located in the Central Region of Mexico (Figure 1). Farms were selected through the Ministry of Agriculture and Livestock's (SAGARPA) census of pig producers in the country, including small producers, according to the number of animals in the farms.

Characteristics of the production units selected

I. Rustic production units.

All the farms had a person in charge of the unit and included a range of between 10 to 50 breeding sows, with 100 to 500 animals in production. The main objective of keeping pigs in this type of production was commercial; however, some breeders said they also used the animals to complement the family diet as well as a resource in case of financial emergencies. It was common for production units to be inhabited by families (the owner or employees) and contain other associated species such as poultry, rabbits, sheep, and cows. Production units were in charge of women and men that took care of the animals and only occasionally hired workers. The production systems in most of the farms were diversified (Figure 2). Very few of the producers used commercial balanced feed as the only source of nutrients; the great majority used forage and oilseeds typical of their regions as well as leftovers. There were large differences in the types of shelter with respect to installation design and the materials used. In the service and gestation areas, as well as in the maternity area, all the sows were kept in pens.

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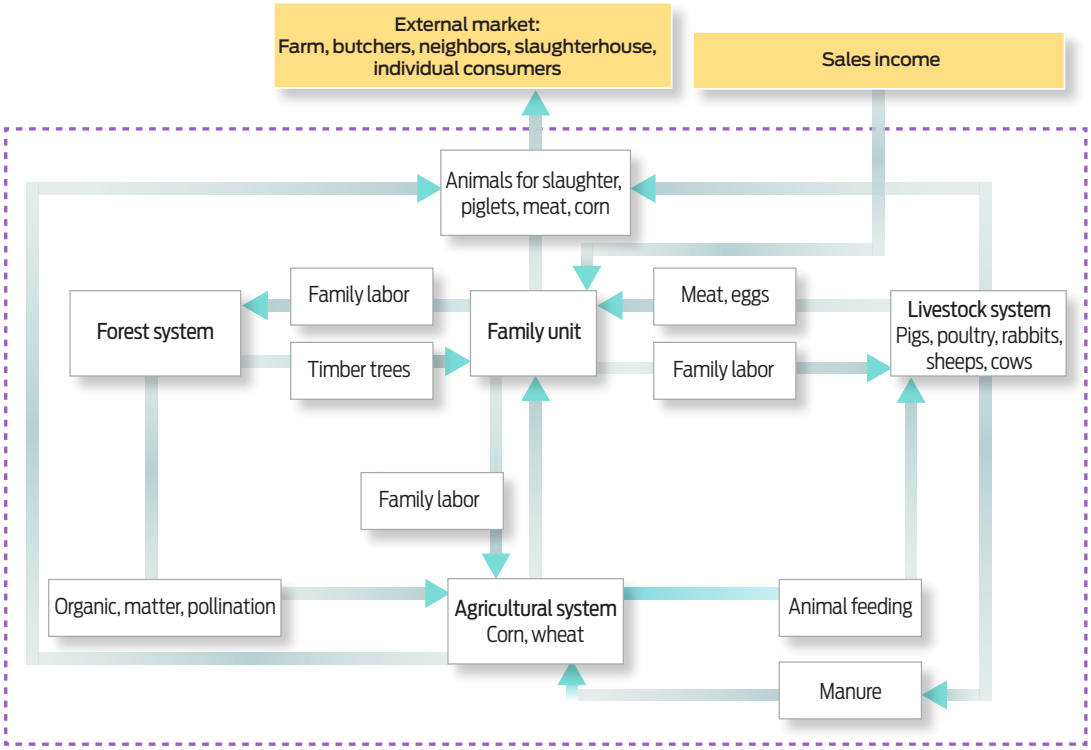

Figure 2. Scheme of the rustic production system, which shows the three systems that comprise it (livestock, agriculture and forestry) and the interactions that exist between them.

II. Technified production units.

All the farms had a person in charge of the unit and included a herd of 100 to 500 breeding sows, resulting in approximately 1000 and 5000 animals in production. The main objective of keeping pigs was a commercial venture and only one producer said that they used the animals as part of the family diet. Most of the production units were not in the same place as the households of the producers and/or workers, and only one producer kept sheep as an associated species. Except for one producer, all farms hired workers who were in charge of animal care. The lands close to the pig rearing systems were intended for the production of maize, sorghum, and aromatic herbs which were sold locally and/or exported (Figure 3). The feeding system in this type of production was based on balanced feed acquired commercially or which the producers prepared themselves. The installations in which the animals were housed had nearly identical designs, including materials and additional features. In the service and gestation areas as well as the maternity areas, all the sows were housed in commercial pens designed especially for the corresponding area.

Procedure for data collection

Welfare assessment system

Animal welfare indicators were measured according to the Welfare Quality protocols,[9] which were validated by the research group that developed them. In the case of pig livestock, because of the differences in location and type of animal, Welfare Quality designed three different protocols, one for sows and piglets on farms (ma-

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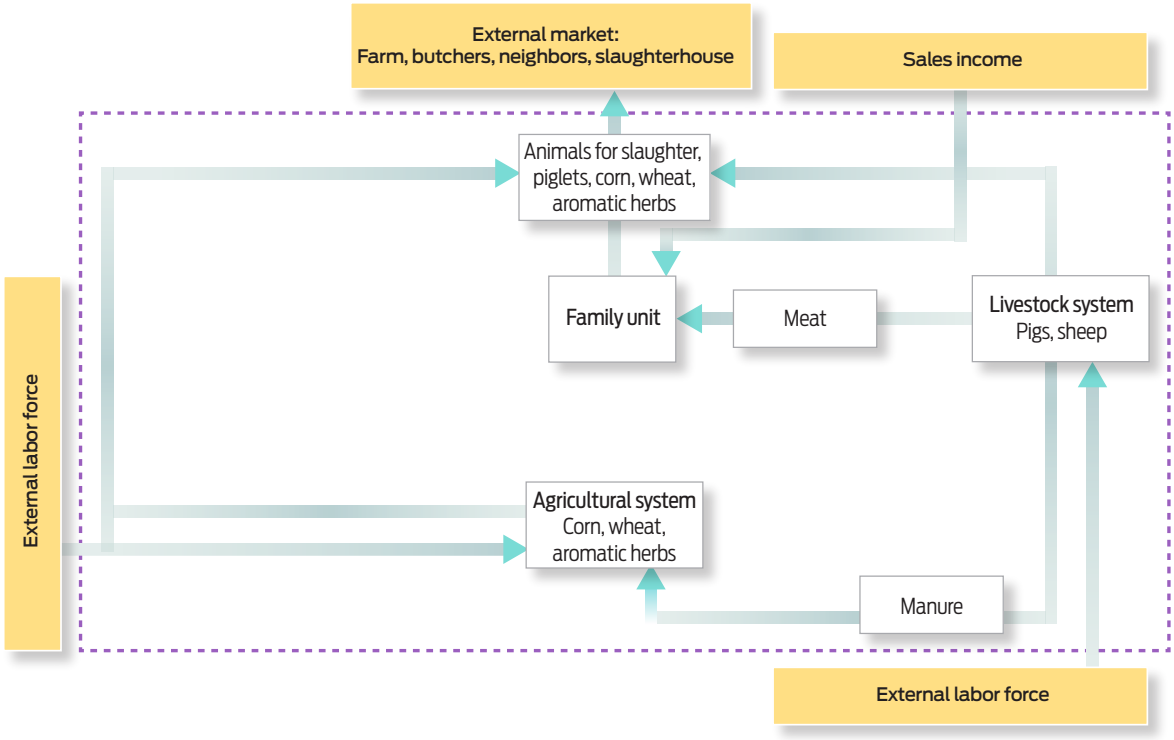

Figure 3. Scheme of the technified production system, which shows the two systems, livestock and agriculture, and the interactions that exist between them.

ternity), one for farm pigs (fattening), and finally, one for pigs in slaughterhouses. In this project, the criteria for maternity and fattening were evaluated. The Welfare Quality evaluation system consists of four principles of animal welfare: good feeding, good housing, good health, and appropriate behaviour. The four principles in turn include 12 independent criteria, which reflect what is meaningful to animals from a scientific point of view.

Statistic analysis

The IBM SPSS Statistics 21 program [10] was used to analyse animal welfare indicators. The criteria *Absence of prolonged hunger, Absence of prolonged thirst, Comfort at rest, Thermal comfort, Ease of movement, Absence of wounds, Absence of diseases, Absence of pain induced by management procedures, Expression of social behaviours, Expression of other behaviours, Good human-animal relationship*, and *Positive emotional states*, evaluated in sows and piglets in farms (maternity) and in farm pigs (fattening) were expressed in proportion; that is, the percentage of animals exhibiting the characteristic to be evaluated was expressed in proportion to the total number of animals sampled during the evaluation. This evaluation was done for each criterion. According to the indications of the WQ protocols,[9] when the number of sows was ≤6, all of the sows were selected. When the number of sows was ≥6 but ≤100, 10 animals in each of the three stages of pregnancy (early, mid-, and late gestation) were identified for the evaluation. Alternatively, if the number of sows was ≥100, the selection was randomized following the WQ protocols criteria.[9] Likewise, when assessing growing pigs, whenever possible, 150 pigs

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from 10 different pens/groups (15 pigs per pen/group) were evaluated. If there were less than 10 pens/groups, the number of pigs inspected inside each pen/group had to increase until reaching a total of 150 animals (or the total number of animals in fattening, in the case of smaller farms). The method was applied at three different stages of the growing/fattening period.[9] The Mann-Whitney test was used to establish whether there were significant differences between the criteria evaluated in the animals in the rustic and technified production units. A difference was considered statistically significant when its P value was less than 0.05.[11]

Integration of results

Once all the measurements were carried out in the production units, a bottom-up approach was followed to produce an overall assessment of animal welfare on the particular production unit: first the data collected was combined to calculate criterion-scores through decision trees, proportions, alarm thresholds, and nonlinear functions (I-spline); then criterion-scores were combined to calculate principle-scores, using Choquet integrals; and finally the production unit was assigned to one welfare category according to the principle-scores obtained.[9]

Each welfare category was defined through "aspiration values". They represented the goal that the farm should try to achieve to be assigned to a given category. It was important that the final classification reflects what can realistically be achieved in practice. Therefore, a farm is considered "excellent" if it scores more than 55 on all principles and more than 80 on two of them, while it was considered "enhanced" if it scores more than 20 on all principles and more than 55 on two of them. Farms with "acceptable" levels of animal welfare score more than 10 on all principles and more than 20 on three of them. Farms that do not reach these minimum standards were not classified.[9]

Results and discussion

Once the Welfare Quality protocol was applied, the results indicated an "enhanced" classification for both rustic and technified production systems, since, according to the protocol, farms that obtain more than 20 points in all principles and more than 55 in two of them will be qualified in this way. The results are presented in Figure 4 and Table 1.

The qualifications that rustic and technified production units obtained in the evaluated criteria are presented in Table 2.

Comparison of animal welfare indicators between rustic and technified production units

Table 3 shows the frequencies of the means of the criteria evaluated during the application of the Welfare Quality protocol in animals in rustic and technified production units. The frequency of criteria corresponding to the principle of *Good health* (*Absence of wounds, Absence of diseases* and *Absence of pain induced by management procedures*) and the criterion *Social behaviour expression* (*Appropriate behaviour principle*) was significantly higher in animals housed in rustic production

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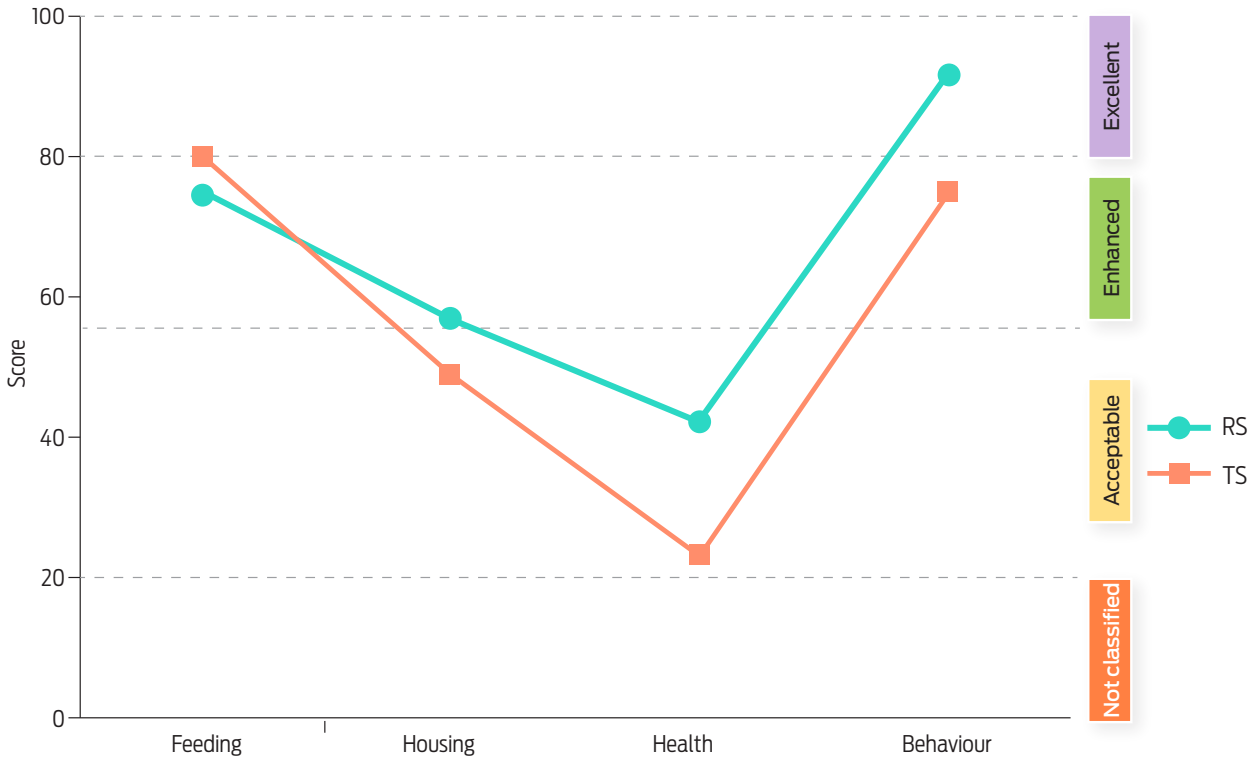

Figure 4. Classification of rustic (RS) and technified (TS) production units within the welfare categories proposed by the Welfare Quality protocol.

Table 1. Qualifications of the principles of the Welfare Quality protocol in rustic and technified production units

Pig production systems	Animals per farm	Good feeding	Good housing	Good health	Appropriate behaviour
1	90	57	40	50	90
2	100	81	63	31	88
3	210	86	50	56	96
4	210	81	63	43	93
5	240	80	63	28	95
6	300	62	55	38	91
7	380	81	62	49	91
8	700	80	52	52	97
9	1000	81	64	22	90
10	1500	100	42	19	57
11	1700	56	23	17	71
12	2000	64	61	16	70
13	5000	97	50	14	63

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Table 2. Qualifications of the criteria evaluated during the application of the Welfare Quality protocol in the animals assessed in rustic (rPU) and technified (tPU) production units

	Welfare Quality Criteria											
UPP	1[a]	2[b]	3[c]	4[d]	5[e]	6[f]	7[g]	8[h]	9[i]	10[j]	11[k]	12[l]
1	100	55	74.75	24	73	67.71	56.38	47	77.63	51.06	76.09	15.94
2	92.87	80	80.44	56	76	86.63	83.97	8	79.53	51.06	85.53	11.54
3	80.1	100	84.7	35	76	66.05	83.97	47	74.54	58.76	88.33	7.8
4	86.21	80	77.61	56	76	32.89	83.97	47	71.47	55.67	84.15	10.47
5	86.21	80	77.6	56	76	86.61	69.46	8	93.19	53.75	85.53	12.03
6	92.87	60	50.67	56	75	25.28	83.97	100	79.53	53.75	85.53	8.4
7	92.87	80	71	56	76	43.86	69.46	47	71.47	53.75	81.42	11.08
8	86.21	80	89.14	35	86	57.23	64.81	47	71.47	58.76	84.15	9.83
9	92.87	80	84.7	56	73	38.28	60.08	8	64.61	53.75	80.07	13.5
10	100	100	35.71	35	80	18.95	56.38	8	51.06	29.28	72.22	19.27
11	69.41	55	71	56	8	21.97	44.66	8	45.56	39.06	78.73	20
12	50.23	100	59.71	59	73	11.25	44.66	8	49.39	39.06	85.53	17.76
13	96.41	100	43.33	56	77	15.87	34.23	8	49.39	33.32	74.79	19.81

[a] Absence of prolonged hunger; [b] Absence of prolonged thirst; [c] Comfort around resting; [d] Thermal comfort; [e] Ease of movement; [f] Absence of injuries; [g] Absence of disease; [h] Absence of pain induced by management procedures; [i] Expression of social behaviours; [j] Expression of other behaviours; [k] Good human-animal relationship; [l] Positive emotional state

Table 3. Mean occurrences and SE of the criteria evaluated during the application of the Welfare Quality protocol in the animals assessed in rustic (rPU) and technified (tPU) production units

Criteria evaluated	rPU	tPU	P value
Absence of prolonged hunger	90.1 ± 6.50	82.5 ± 19.15	NS
Absence of prolonged thirst	76.4 ± 14.92	85.8 ± 18.01	NS
Comfort around resting	73.8 ± 11.07	63.9 ± 21.69	NS
Thermal comfort	48.4 ± 13.31	49.5 ± 11.29	NS
Ease of movement	75.5 ± 1.13	66.3 ± 28.90	NS
Absence of injuries	58.4 ± 24.82	27.3 ± 17.34	< 0.05
Absence of disease	75.9 ± 10.98	50.8 ± 11.51	< 0.01
Absence of pain induced by management procedures	43.4 ± 30.98	14.5 ± 15.92	≤ 0.05
Expression of social behaviours	78.2 ± 7.44	55.3 ± 10.30	< 0.01
Expression of other behaviours	53.9 ± 2.67	42.2 ± 11.60	NS
Good human-animal relationship	83.8 ± 3.97	79.2 ± 5.17	NS
Positive emotional state	11.0 ± 2.68	16.7 ± 4.14	< 0.05

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units ($U = 5$, $P < 0.05$; $U = 2.5$, $P < 0.01$; $U = 9$, $P \leq 0.05$, and $U = 1$, $P < 0.01$, respectively), whereas the frequency corresponding to the *positive emotional states* criterion, belonging to the *appropriate behaviour* principle, was significantly higher in the animals of the technified production units ($U = 6$, $P < 0.05$). On the other hand, there were no significant differences between the animals of the rustic and technified production units in the criteria included in the principles *Good feeding* and *Good housing*, nor in the criteria *Expression of other behaviours* and *Good human-animal relationship* in the principle of *Appropriate behaviour*.

One of the first interesting results was related to the health of the animals (absence of wounds, absence of diseases and pain induced by management procedures), where the frequency of these criteria was significantly higher in animals housed in rustic production units. In general, when questioning the producers about which diseases were the most common on their farms, most responded with digestive and respiratory problems, which coincide with findings described in the work of Losada.[12] However, it should be noted that the incidence of other productive diseases (Circovirosis, Mycoplasmosis, PRRS, Parvovirosis, Leptospirosis, Erisipelosis) was higher in technified systems. The relationship between the density of animals in confinement and their health has been examined by several researchers.[13-16] With the industrialization of agriculture, people began to use "technological sanders" –such as antibiotics, vaccines, bacterins, hormones, air-handling systems, and other technological innovations- that allowed for intensive production. In a traditional husbandry system, these practices could have reduced farm productivity, but in the technified system, they increased farm productivity from an economic standpoint.[17]

In relation to the presence of wounds in the animals, one of the main causes was related to the movement of piglets after weaning –and social regrouping. It is common to move the animals out of the group where they were raised, either for productive or breeding reasons, which leads to social instability within the group.[14] The exposure to new and unstable social situations can induce fear, which, when combined with no possibilities of escape, may result in intense fighting.[14,18,19] Studies demonstrate that pigs can discriminate between familiar and unfamiliar individuals through olfactory, visual, and probably auditory cues and that environmental pollutants (e.g., high levels of ammonia) may alter preferences for approaching familiar or unfamiliar individuals.[19-22] In established groups, one important way of ensuring that individuals do not constrain the behaviour of fellow group members or adversely affect their welfare in other ways is to provide animals with opportunities to avoid each other.[14] Some researchers suggest the use of visual barriers to reduce aggression, and for pigs specifically, pop-holes in which the head can be hidden appear to be effective in terminating or avoiding aggressive attacks.[19,23,24]

With regards to other health indicators, specifically the absence of pain induced by management procedures, it was notable that this factor was practically the same between rustic and technified systems. A recurring practice in this type of system (apart from castration and teeth clipping) was the tail docking of piglets. Pigs have always had a tendency to bite each other's tails. Under extensive conditions, pigs have the space to get away from one another: it is only in confinement that tail-biting became a serious problem.[16,25-27] The response of the producer has been to amputate the distal half of the tail, a surgical solution to a "human induced" problem. It has been suggested by several researchers that tail-biting can be prevented

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by making changes in housing, changes in the animals' diet (mainly protein and mineral balance), and providing substrates (straw, compost, newspaper, ties), as well as eliminating atmospherically uncomfortable factors (high levels of ammonia, CO2, humidity, or low barometric pressure).[24,25,27-31] Boredom is also a relevant factor in these circumstances. In rustic systems, where animal density is lower, sometimes rims, chains, or alfalfa branches are placed within enclosures as sources of entertainment for the animals, a situation which technified systems "cannot afford". The concept of "modernity" in pig production becomes intolerant in this regard, since the presence of distractors for animals is rarely considered by producers.

With reference to the expression of social behaviour, the animals in the technified systems obtained a lower rating in this indicator because they exhibited a greater amount of socio-negative behaviours, including aggression to conspecifics. Limited access to resources along with high animal densities gives rise to such competitive situations.[14,16,24] In the farm environment, group size and density are predetermined to maximize economic returns (exogenous control of group size),[14] which implies that social behaviour of animals has to adapt to the density established by the producer.[19] In both evaluated systems the groups were exogenous, formed by the needs established by the producer, who in the majority of the cases sought homogeneity in the size of the animals. In the restricted farm environment, group size cannot be self-regulated because animals have no opportunities to leave if attacked by a group member. The impossibility of leaving the group creates a situation that increases the potential for costly aggressive interactions and may favour despotic behaviour by some individuals.[19,32] Provision of opportunities to hide and retreat from aggressive conspecifics may be a wise management strategy to reduce the negative consequences of aggressive interactions.[14] Finally, it should be remembered that Vanhonacker et al.[33] mention that social concern about animal density as well as pen size is imperative within the overall picture of animal welfare on farms.

Another relevant aspect was related to the positive emotional states of the animals. This criterion presents a different measurement scale: the lower the score obtained, the higher the final grade will be. The frequency of this indicator was significantly higher in the animals of the technified production units, which, as mentioned above, is interpreted as a lower total score. The affective states of animals play a central role in our understanding of animal welfare.[34] In recent years, evidence of the cognitive and emotional capacities of animals has grown, and it has become increasingly clear that they are conscious, experiential individuals.[35] In this context, common sense present in social ethics does not doubt that animals are capable of being bored [36] – a clear example is the criticism of sow stalls – and production systems are judged according to this knowledge.[25] Scientific ideology has rejected such evaluations as "anthropomorphic", however, as Rollin [25] and Balcombe [35] point out, a precise and scientific meaning can be given to terms such as "bored" when applied to animals. On the other hand, many of the important questions about animal welfare arise when people, based on their daily understanding of animals, show concern about their affective states.[33,37] Finally, there is an emerging view that welfare should be more than just the absence of suffering (pain-avoider/pleasure-seeker).[35,38] Balcombe [35] points out that when capacity for pleasure is included, the arguments for welfare become stronger, as Regan [39] mentioned "lives with pleasurable moments are lives of intrinsic value".

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Clearly, the most difficult challenge for the livestock sector is to satisfy the behavioural needs (psychological/biological) of animals in technified systems. However, it should be noted that this process is not starting from zero. Many countries have been conducting research on alternative production systems in recent years.[2,40] In addition, the need for rustic systems to stop considering technified production as the "model to follow" should be re-examined. The increase in consumer demand for animal products derived from an "environmentally-friendly" production system (including animal welfare) has put pressure on production chains in order to certify or improve the welfare status of animals.[41-43] Thus, recent concepts of sustainability in livestock production have paid great attention to animal welfare issues.[15,33,42,44-47] Animal welfare problems have become a compelling reason for the public to perceive some systems as unacceptable and therefore unsustainable unless some modification is made. In this context, it is clear that animal welfare is becoming a strong motivating factor for members of the public who demand a change on the part of producers, companies, and governments.

Conclusions

There is wide variation between rustic pig production systems in Mexico – as a result, this study was unable to use repetitions. We acknowledge that without proper repetitions the possibility of drawing strong conclusions is limited. However, our results provide useful information on aspects related to the welfare of pigs in these types of farms. The criteria related to the WQ principles health (absence of injuries, absence of disease, and absence of pain induced by management procedures) and behaviour (expression of social behaviours, positive emotional state) are sensitive to changes in the housing and management of pigs. The high occurrences of health and behaviour problems recorded in technified systems are an indicator of poor welfare. The Welfare Quality protocol seems to be a useful tool to differentiate farms on the basis of reliable indicators (criteria) to be used for sustainability assessments.

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Conflicts of interest

All authors declare that there are no present or potential conflicts of interest among the authors and other people or organizations that could inappropriately bias their work.

Author contributions

Natyieli Losada-Espinosa: conducted the experiments, analysed the data, and wrote the manuscript.

María Elena Trujillo-Ortega: designed the research and analysed the data.

Francisco Galindo: designed the research, analysed the data, and revised and edited the manuscript.

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